

### **REMARKS**

The remainder of this Amendment After Final Rejection is being submitted under appropriate subheadings for the convenience of the Examiner.

#### **Interview Summary**

Applicants' Attorney, N. Scott Pierce, would like to thank the Examiner for conducting a telephonic interview on January 23, 2006 and for his helpful suggestions. Claims 20-22 have been added pursuant to the Examiner's comments and suggestions.

#### **Amendments to the Claims**

New Claims 20-22 are directed to methods of polymerizing an aromatic monomer. New Claims 20 and 22 recite specific examples of non-proteinaceous amphipathic groups. Support for these specific examples can be found in the specification, for example, on page 5, line 26 through page 6, line 4. New Claim 21 recites the use of a water soluble hematin catalyst, wherein the hematin catalyst has been derivatized with one or more non-proteinaceous amphipathic groups and wherein the derivatized hematin catalyst is soluble in a pH range between about pH 1 and about pH 12. Support for this new claim can be found in originally-filed Claim 1 and in the specification, for example on page 6, lines 9-10. In particular, support for the recited pH range can be found in the specification on page 6, lines 9-10. No new matter has been added.

#### **Applicants' Invention**

Applicants' claimed method of polymerizing an aromatic monomer includes combining an aromatic monomer with a water-soluble hematin catalyst, wherein the hematin catalyst has been derivatized with one or more non-proteinaceous amphipathic groups.

#### **Advantages of Applicants' Invention**

As described in the background section of the current application, polymerization of aromatic monomers to form electrically conductive aromatic polymers generally requires acidic conditions. Horseradish peroxidase has been used as an enzyme, but, like other peroxidases, it is

relatively inactive at low pH and is prohibitively expensive to use commercially. Hematin can be used to mimic horseradish peroxidase, but has low solubility in acidic aqueous media.

Applicants' claimed method of polymerizing an aromatic monomer includes catalyzing the polymerization reaction with a hematin that has been derivatized with a non-proteinaceous amphipathic group. The derivatized hematin is soluble in water at low pH and, therefore, successfully catalyzes reaction of aromatic monomers at pHs significantly lower than can be achieved by use of native hematin. Further, Applicants have also demonstrated that, even at neutral pH, where native hematin is known to be able to catalyze polymerization of aromatic monomers, use of water-soluble hematin derivatized with one or more non-proteinaceous amphipathic groups by applicants' claimed method results in a significant improvement in polymerization reactivity over native hematin as a catalyst in such reactions.

Rejections of Claims Under 35 U.S.C. § 103(a) As Being Unpatentable Over Akkara *et al.* In View of Przybycien *et al.*

In response to Applicants' amendment of Claim 1 to include the limitation that the hematin catalyst is water soluble and Applicants' argument that Przybycien *et al.* require that metalloporphyrins and metallophthalocyanines be immobilized and therefore are not water-soluble, the Examiner stated that immobilization as a characteristic has "nothing to do with the water-soluble characteristic." Further, the Examiner stated that Akkara *et al.* "does disclose hematin catalyzed polymerization of phenyl compounds (see Title) in that the phenolic monomers undergo oxidative dehydrogenation reaction catalyzed by hematin (see page 2377, left hand column)," and that this is the water soluble characteristic. Further, the Examiner stated that Applicants' amendment of the claim to include water solubility does not have patentable weight because Applicants did "not disclose any claimed structure to support" the water-soluble characteristic.

In the first Office Action, dated December 8, 2004, the Examiner stated that Akkara *et al.* do "not disclose [that] the hematin catalyst has been derivatized with one or more non-proteinaceous amphipathic groups . . . ." The Examiner further stated that "one of ordinary skill in the art would be motivated to polymerize the aromatic monomer as disclosed in Akkara employing a hematin derivative, as disclosed in Przybycien, in order to gain the advantages of the combination of the references, that being electrochemical separation in which metalloporphyrins and metallophthalocyanines are utilized as the stationary phrase." In addition, the Examiner

stated that “the replacement of said hematin by the use of hematin derivative to the added use or properties would not provide unexpected results to one of ordinary skill in the art.”

As described in Akkara *et al.*, at page 2378, right-hand column, hematin was employed to attempt catalyzation of ethylphenol at pH values of 4.0, 5.0, 7.0, 8.0 and 11.0. As shown in Table 2, page 2379 of Akkara *et al.*, and as described in the Results and Discussion, activity of hematin was low or non-existent at pHs of 4.0 and 5.0. Akkara *et al.* specifically state in the right-hand column of page 2379 that “The low activity of hematin at low pH is due to its limited solubility”:

The low activity of hematin at low pH is due to its limited solubility, which restricted its activity. For further study, pH = 11.0 was used because hematin had a higher solubility and activity.

By way of contrast, at page 13, line 22 through page 20, line 25, Applicants provide several examples where hematin derivatized with polyethyleneglycol (PEG) was successfully employed as a catalyst to polymerize aniline. In Example 2, the pH was maintained at pH 1. In Examples 3-4, a range of pH conditions from 1 to 4 was employed. The reaction was maintained at pH 4.3 in Example 5, and at pH 4 in Example 7. Further, a comparison of enzymatic activity of PEG-derivatized hematin with native hematin was conducted at pH 7.0 in Example 8. As described in Example 8, “the PEG-hematin complex was also found to catalyze the polymerization of phenol at pH 7.0 more efficiently than that compared to the native hematin and peroxidase.” For example, a typical yield of polymerization of a phenol compound at pH 7.0 is 95% or higher for the PEG-hematin complex, while 50% for hematin as shown in Table 2 of Akkara *et al.* As stated by Applicants in Example 8 and based on the results observed, “modification of the hematin with PEG was observed to significantly improve the reactivity to suit the desired reaction conditions leading to the formation of polyphenol.” This improved reactivity of hematin derivatized with PEG could not have been predicted based on the teachings of Akkara *et al.*

There is no disclosure or suggestion in Akkara *et al.* that increasing solubility of hematin by derivitization with one or more non-proteinaceous amphipathic groups, as required by Applicants’ claimed method, would enable hematin to be active at low pH, nor is there any disclosure or suggestion in Akkara *et al.* that such derivitization of hematin would increase enzymatic activity at a pH, such as neutral pH, where native hematin is known to catalyze

polymerization of aromatic monomers. Therefore, Akkara *et al.* do not disclose or suggest use of a water-soluble hematin catalyst, wherein the hematin catalyst has been derivatized with one or more non-proteinaceous amphipathic groups, to polymerize an aromatic monomer, as claimed by Applicants.

Przybycien *et al.* do not remedy the deficiencies of Akkara *et al.* Specifically, Przybycien *et al.* do not disclose or suggest use of hematin, or any derivative of hematin, to catalyze polymerization of an aromatic monomer. Therefore, neither Akkara *et al.* nor Przybycien *et al.* disclose or suggest, either separately or in combination, Applicants' claimed method of polymerizing an aromatic monomer, wherein an aromatic monomer is combined with a water-soluble hematin catalyst, that has been derivatized with one or more non-proteinaceous amphipathic groups.

Applicants' claimed method, as set forth in independent Claim 1 and dependent Claims 2-19, meets the requirements of 35 U.S.C. § 103(a) over Akkara *et al.* in view of Przybycien *et al.*, taken either separately or in combination.

Further, contrary to the Examiner's statement that the "water-soluble characteristic does not have patentable weight in this particular case since Applicant does not disclose any claimed structure to support" this characteristic, Applicants provide detailed descriptions of suitable water-soluble hematins at, for example, page 5, line 24 through page 6, line 10. Methods of forming water-soluble derivatized hematins are described at, for example, page 8, line 27 through page 9, line 26. A specific example of derivatizing hematin is set forth in Example 1, at page 11, line 24 through page 13, line 21. As discussed above, examples of use of derivatized hematin as a catalyst to successfully polymerize an aromatic monomer, aniline, is described in Examples 2-8, at page 13, line 22 through page 20, line 25. Therefore, Applicants have provided several structures, methods for their synthesis, and demonstrations of the use of water-soluble derivitized hematins as catalysts to polymerize an aromatic monomer, as claimed.

## SUMMARY AND CONCLUSIONS

Applicants' claimed method for polymerizing an aromatic monomer meets the requirements of 35 U.S.C. § 103(a) in view of Akkara *et al.* and Przybycien *et al.*, taken either separately or in combination. Further, Applicants provide support for the amendment made to

Claim 1 in the reply to the first Office Action, limiting the hematin catalyst to a water-soluble hematin catalyst.

Applicants respectfully request reconsideration and withdrawal of the outstanding rejection and allowance of the application. If the Examiner feels that a telephone conference would expedite prosecution, he is respectfully invited to contact Applicants' undersigned attorney.

Respectfully submitted,

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Docket No.: 2328.2003-002

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Applicant: Sukant Tripathy, et al.

Application No.: 10/826,623

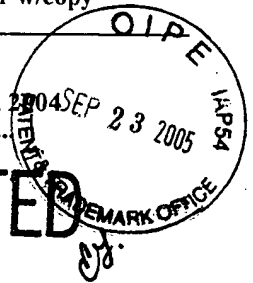
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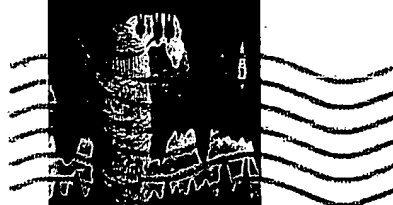
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